



## X-linked adrenoleukodystrophy

X-linked adrenoleukodystrophy is a genetic disorder that occurs primarily in males. It mainly affects the nervous system and the adrenal glands, which are small glands located on top of each kidney. In this disorder, the fatty covering (myelin) that insulates nerves in the brain and spinal cord is prone to deterioration (demyelination), which reduces the ability of the nerves to relay information to the brain. In addition, damage to the outer layer of the adrenal glands (adrenal cortex) causes a shortage of certain hormones (adrenocortical insufficiency). Adrenocortical insufficiency may cause weakness, weight loss, skin changes, vomiting, and coma.

There are three distinct types of X-linked adrenoleukodystrophy: a childhood cerebral form, an adrenomyeloneuropathy type, and a form called Addison disease only.

Children with the cerebral form of X-linked adrenoleukodystrophy experience learning and behavioral problems that usually begin between the ages of 4 and 10. Over time the symptoms worsen, and these children may have difficulty reading, writing, understanding speech, and comprehending written material. Additional signs and symptoms of the cerebral form include aggressive behavior, vision problems, difficulty swallowing, poor coordination, and impaired adrenal gland function. The rate at which this disorder progresses is variable but can be extremely rapid, often leading to total disability within a few years. The life expectancy of individuals with this type depends on the severity of the signs and symptoms and how quickly the disorder progresses. Individuals with the cerebral form of X-linked adrenoleukodystrophy usually survive only a few years after symptoms begin but may survive longer with intensive medical support.

Signs and symptoms of the adrenomyeloneuropathy type appear between early adulthood and middle age. Affected individuals develop progressive stiffness and weakness in their legs (paraparesis), experience urinary and genital tract disorders, and often show changes in behavior and thinking ability. Most people with the adrenomyeloneuropathy type also have adrenocortical insufficiency. In some severely affected individuals, damage to the brain and nervous system can lead to early death.

People with X-linked adrenoleukodystrophy whose only symptom is adrenocortical insufficiency are said to have the Addison disease only form. In these individuals, adrenocortical insufficiency can begin anytime between childhood and adulthood. However, most affected individuals develop the additional features of the adrenomyeloneuropathy type by the time they reach middle age. The life expectancy of individuals with this form depends on the severity of the signs and symptoms, but typically this is the mildest of the three types.

Rarely, individuals with X-linked adrenoleukodystrophy develop multiple features of the disorder in adolescence or early adulthood. In addition to adrenocortical insufficiency, these individuals usually have psychiatric disorders and a loss of intellectual function (dementia). It is unclear whether these individuals have a distinct form of the condition or a variation of one of the previously described types.

For reasons that are unclear, different forms of X-linked adrenoleukodystrophy can be seen in affected individuals within the same family.

## Frequency

The prevalence of X-linked adrenoleukodystrophy is 1 in 20,000 to 50,000 individuals worldwide. This condition occurs with a similar frequency in all populations.

## Genetic Changes

Mutations in the *ABCD1* gene cause X-linked adrenoleukodystrophy. The *ABCD1* gene provides instructions for producing the adrenoleukodystrophy protein (ALDP), which is involved in transporting certain fat molecules called very long-chain fatty acids (VLCFAs) into peroxisomes. Peroxisomes are small sacs within cells that process many types of molecules, including VLCFAs.

*ABCD1* gene mutations result in a shortage (deficiency) of ALDP. When this protein is lacking, the transport and subsequent breakdown of VLCFAs is disrupted, causing abnormally high levels of these fats in the body. The accumulation of VLCFAs may be toxic to the adrenal cortex and myelin. Research suggests that the accumulation of VLCFAs triggers an inflammatory response in the brain, which could lead to the breakdown of myelin. The destruction of these tissues leads to the signs and symptoms of X-linked adrenoleukodystrophy.

## Inheritance Pattern

X-linked adrenoleukodystrophy is inherited in an X-linked pattern. A condition is considered X-linked if the mutated gene that causes the disorder is located on the X chromosome, one of the two sex chromosomes in each cell. In males (who have only one X chromosome), one altered copy of the *ABCD1* gene in each cell is sufficient to cause X-linked adrenoleukodystrophy. Because females have two copies of the X chromosome, one altered copy of the *ABCD1* gene in each cell usually does not cause any features of X-linked adrenoleukodystrophy; however, some females with one altered copy of the gene have health problems associated with this disorder. The signs and symptoms of X-linked adrenoleukodystrophy tend to appear at a later age in females than in males. Affected women usually develop features of the adrenomyeloneuropathy type.

## Other Names for This Condition

- Addison disease and cerebral sclerosis
- melanodermic leukodystrophy
- Schilder-Addison Complex
- Schilder disease
- Siemerling-Creutzfeldt disease
- X-ALD

## Diagnosis & Management

These resources address the diagnosis or management of X-linked adrenoleukodystrophy:

- GeneReview: X-Linked Adrenoleukodystrophy  
<https://www.ncbi.nlm.nih.gov/books/NBK1315>
- Genetic Testing Registry: Adrenoleukodystrophy  
<https://www.ncbi.nlm.nih.gov/gtr/conditions/C0162309/>
- Genomics Education Programme (UK)  
<https://www.genomicseducation.hee.nhs.uk/resources/genetic-conditions-factsheets/item/71-adrenoleukodystrophy>
- MedlinePlus Encyclopedia: Adrenoleukodystrophy  
<https://medlineplus.gov/ency/article/001182.htm>
- National Marrow Donor Program  
<https://bethematch.org/for-patients-and-families/learning-about-your-disease/adrenoleukodystrophy/>
- X-linked Adrenoleukodystrophy Database: Diagnosis of X-ALD  
<http://www.x-ald.nl/clinical-diagnosis/diagnosis-of-x-ald/>

These resources from MedlinePlus offer information about the diagnosis and management of various health conditions:

- Diagnostic Tests  
<https://medlineplus.gov/diagnostictests.html>
- Drug Therapy  
<https://medlineplus.gov/drugtherapy.html>
- Surgery and Rehabilitation  
<https://medlineplus.gov/surgeryandrehabilitation.html>

- Genetic Counseling  
<https://medlineplus.gov/geneticcounseling.html>
- Palliative Care  
<https://medlineplus.gov/palliativecare.html>

## **Additional Information & Resources**

### MedlinePlus

- Encyclopedia: Adrenoleukodystrophy  
<https://medlineplus.gov/ency/article/001182.htm>
- Health Topic: Adrenal Gland Disorders  
<https://medlineplus.gov/adrenalglanddisorders.html>
- Health Topic: Endocrine Diseases  
<https://medlineplus.gov/endocrinediseases.html>
- Health Topic: Leukodystrophies  
<https://medlineplus.gov/leukodystrophies.html>

### Genetic and Rare Diseases Information Center

- X-linked adrenoleukodystrophy  
<https://rarediseases.info.nih.gov/diseases/5758/x-linked-adrenoleukodystrophy>

### Additional NIH Resources

- NINDS Adrenoleukodystrophy Information Page  
<https://www.ninds.nih.gov/Disorders/All-Disorders/Adrenoleukodystrophy-Information-Page>

### Educational Resources

- Cleveland Clinic: What is Adrenoleukodystrophy?  
<http://my.clevelandclinic.org/health/articles/what-is-adrenoleukodystrophy>
- Disease InfoSearch: Adrenoleukodystrophy  
<http://www.diseaseinfosearch.org/Adrenoleukodystrophy/242>
- Disease InfoSearch: Childhood-Onset Cerebral X-Linked Adrenoleukodystrophy  
<http://www.diseaseinfosearch.org/Childhood-Onset+Cerebral+X-Linked+Adrenoleukodystrophy/1334>
- Genetic Alliance: Disease InfoSearch  
<http://www.diseaseinfosearch.org/Adrenoleukodystrophy+X-Linked/243>
- Kennedy Krieger Institute  
<https://www.kennedykrieger.org/patient-care/diagnoses-disorders/leukodystrophy/adrenoleukodystrophy-ald>

- MalaCards: adrenoleukodystrophy  
<http://www.malacards.org/card/adrenoleukodystrophy>
- Orphanet: X-linked adrenoleukodystrophy  
[http://www.orpha.net/consor/cgi-bin/OC\\_Exp.php?Lng=EN&Expert=43](http://www.orpha.net/consor/cgi-bin/OC_Exp.php?Lng=EN&Expert=43)
- Washington University, St. Louis: Neuromuscular Disease Center  
<http://neuromuscular.wustl.edu/spinal/fsp.html#aml>
- X-linked Adrenoleukodystrophy Database  
<http://www.x-ald.nl/>

#### Patient Support and Advocacy Resources

- CLIMB: Children Living with Inherited Metabolic Diseases  
<http://www.climb.org.uk/>
- National Organization for Rare Disorders (NORD): Adrenoleukodystrophy  
<http://rarediseases.org/rare-diseases/adrenoleukodystrophy/>
- The Adrenoleukodystrophy Foundation  
<http://www.aldfoundation.org/>
- The Stop ALD Foundation  
<http://www.stopald.org/>
- University of Kansas Medical Center Resource List  
<http://www.kumc.edu/gec/support/leukodys.html>

#### GeneReviews

- X-Linked Adrenoleukodystrophy  
<https://www.ncbi.nlm.nih.gov/books/NBK1315>

#### Genetic Testing Registry

- Adrenoleukodystrophy  
<https://www.ncbi.nlm.nih.gov/gtr/conditions/C0162309/>

#### ClinicalTrials.gov

- ClinicalTrials.gov  
<https://clinicaltrials.gov/ct2/results?cond=%22x-linked+adrenoleukodystrophy%22>

#### Scientific articles on PubMed

- PubMed  
<https://www.ncbi.nlm.nih.gov/pubmed?term=%28Adrenoleukodystrophy%5BMAJR%5D%29+AND+%28X-linked+adrenoleukodystrophy%5BTIAB%5D%29+AND+english%5BIa%5D+AND+human%5Bmh%5D+AND+%22last+720+days%22%5Bdp%5D>

## OMIM

- ADRENOLEUKODYSTROPHY  
<http://omim.org/entry/300100>

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